SECTION C – STATEMENT OF WORK

1.0   INTRODUCTION

This statement of work describes the effort necessary to provide robotics simulation services; vehicle guidance, navigation, and control simulation and flight software services; and graphics simulation services support to the NASA Lyndon B. Johnson Space Center (JSC) and its external customers for both ground and space flight applications. As a part of this effort, the Contractor shall provide engineering and training simulation support for the International Space Station (ISS) Program, Multi-Purpose Crew Vehicle (MPCV) Program, Commercial Crew and Cargo Program (CCCP), and other advanced programs.

2.0   SCOPE

The primary objective of this contract is to support simulation model development, integration, verification, validation, analysis, documentation, maintenance, and troubleshooting support of Trick-based non-real-time (NRT) and real-time (RT) human-in-the-loop (HITL) simulations including:

- On-orbit robotic manipulator systems
- Advanced future robotic systems
- Software, Robotics, and Simulation Division (SRSD)-based robotic projects
- Guidance, navigation, and control (GN&C) of space-based vehicles for all flight phases including rendezvous, proximity operations, and docking
- On-Board Computer Systems (OBCS) simulations and emulation of Flight Software (FSW) systems
- Astronomical object surface interaction of space-based vehicles

The primary purpose of these simulations is to address engineering analysis, operations, and training requirements. Use and knowledge of the Trick Simulation Environment is a primary requirement, as well as experience with the space-based robotics, vehicle GN&C and flight software emulation, and astronomical object surface interaction of space-based vehicles mentioned above.

To meet SRSD simulation RT HITL scene visualization requirements, excluding Virtual Reality, use and knowledge of the Engineering Dynamic Onboard Ubiquitous Graphics (DOUG) Graphics for Exploration (EDGE) and associated graphics technologies is a primary requirement.

Another objective of this contract is to provide development and support services for avionics and embedded FSW systems.

3.0   PRODUCT DESCRIPTIONS

3.1   ROBOTICS SIMULATION SERVICES

The Contractor shall provide simulation development, integration, verification, validation, analysis, documentation, maintenance, and troubleshooting support for the space-based robotic systems simulation model efforts managed within the SRSD. Robotic modeling and simulation tasks include but are not limited to:

- Highly efficient articulated rigid and flexible multibody dynamics (including friction),
- Seamless integrated multibody/orbital dynamics for robotics operations in the orbital setting,
- Hard-surface contact dynamics modeling for payload berthing mechanism interfaces or end-effector to grapple fixture interfaces needed for payload/vehicle capture, and
- Dynamic state transition management to account for operations such as payload capture/releases, payload or vehicle berthing/unberthing, and handoff (manipulator to manipulator or manipulator to fixed structure).

Specific responsibilities shall include maintenance and upgrade of SRSD simulations to meet engineering analysis, operations, and training customer requirements, as well as the capability to resolve verification and validation issues related to supporting Space Station Remote Manipulator System (SSRMS), Special Purpose Dexterous Manipulator (SPDM), and all other robotic simulation models managed within SRSD. Incorporation of miscellaneous models (e.g., contact dynamics, mechanical systems, or vehicle flight control) from organizations external to SRSD into robotics simulations will be addressed as required in task orders.

3.2   RENDEZVOUS, PROXIMITY OPERATIONS AND DOCKING SIMULATION SERVICES

The Contractor shall provide simulation development, integration, verification, validation, analysis, documentation, maintenance, and troubleshooting support for space-based vehicle rendezvous, proximity operations, and docking simulation efforts managed within the SRSD. These tasks include but are not limited to:

- High fidelity orbital dynamics and natural environment modeling,
- Combined orbital body/multibody dynamics modeling for integrated vehicle with articulated body operational scenarios (e.g., rotating solar arrays),
- Vehicle GN&C modeling, including appropriate level of detail for flight controls/flight software, hardware sensors, and effectors,
- Docking mechanism and contact dynamics modeling for programmatic systems such as the NASA Docking System (NDS).

Specific responsibilities shall include maintenance and upgrade of SRSD simulations to meet engineering analysis, operations, and training customer requirements, as well as the capability to resolve verification and validation issues related to supporting rendezvous, proximity operations, and docking simulation models. Incorporation of miscellaneous models (e.g., contact dynamics, mechanical systems, or vehicle flight control) from organizations external to SRSD into rendezvous, proximity operations, and docking simulations will be addressed as required in task orders.

3.3   ASTRONOMICAL OBJECT SURFACE INTERACTION SIMULATION SERVICES

The Contractor shall provide simulation development, integration, verification, validation, analysis, documentation, maintenance, and troubleshooting support for space-based vehicle surface interaction with astronomical object simulation efforts managed within the SRSD. Space-based vehicle surface interaction with astronomical object modeling includes but is not limited to soil/regolith/rock contact interaction modeling with lander or rover vehicles, robotics systems, and other anchoring type mechanisms. Contact and surface interaction modeling considerations include but are not limited to:

- Space-based vehicle wheel, track, or lander footpad modeling with traction and/or slippage with various astronomical object surface characteristics,
- Robotic systems attachment or excavating interaction with various astronomical object surface materials, and
- Other anchoring type mechanisms stabilizing on various astronomical surface characteristics with appropriate space-based vehicle imparted loads and slippage.

Specific responsibilities shall include maintenance and upgrade of SRSD simulations to meet engineering analysis, operations, and training customer requirements, as well as analysis of verification and validation issues related to supporting surface interaction simulation models. These services include but are not limited to lander interaction with astronomical object surface as well as rover and manipulator interaction with astronomical object surfaces. Incorporation of miscellaneous models (e.g., contact dynamics, mechanical systems, or vehicle control) from organizations external to SRSD into astronomical object surface interaction simulations will be addressed as required in task orders.

3.4   GRAPHICS SIMULATION SERVICES

The Contractor shall provide development, integration, maintenance, and troubleshooting support services for 3D graphics capabilities needed for SRSD RT simulation visualization and NRT engineering analysis. Trick-based simulation to graphics communication library capabilities, various model format loaders, software plug-ins, and other user specific customization will be addressed as required in task orders.

3.5   FLIGHT SOFTWARE AND AVIONICS SERVICES

The Contractor shall provide development, integration, maintenance, and troubleshooting support services for avionics and embedded FSW systems. Capabilites including, but not limited to, implementing core FSW capabilities on various target architectures and platforms, and developing applications to perform, control and monitor vehicle systems for proof-of-concept mission scenarios, will be addressed as required in task orders.

4.0   DATA REQUIREMENTS DESCRIPTIONS

The contractor shall comply with the Data Requirement Descriptions (DRD) set forth in section J, Attachment J-02, of the contract.

5.0   APPLICABLE DOCUMENTS

Documents applicable to this Statement of Work are listed in Attachment J-11, List of Applicable Documents, or in task orders. Documents listed are available at the JSC and Engineering Directorate homepage, or as specified in task orders. The contractor shall ensure that the official, latest version of the applicable documents is utilized in performance of this contract.

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